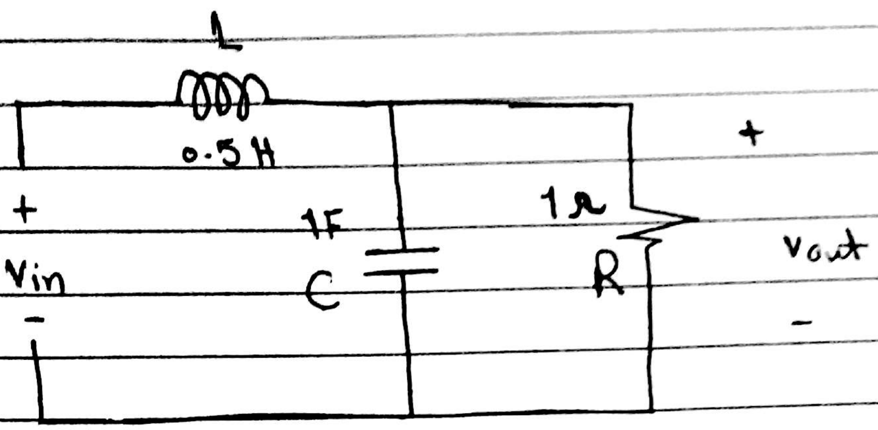
No7,



$x_1 = v_C \quad , \quad x_2 = i_L$

$v_{in} = v_L + v_C \longrightarrow v_{in} = L\dfrac{di_L}{dt} + v_C$

$\therefore \dot{x}_2 = \dfrac{1}{L} v_{in} - \dfrac{1}{L} x_1 \longrightarrow (1)$

$I = I_L = I_C + I_R$

$\therefore I_L = C\dfrac{dv_C}{dt} + \dfrac{v_R}{R}$

$\because v_R = v_C \longrightarrow \therefore I_L = C\dfrac{dv_C}{dt} + \dfrac{v_C}{R}$

$\therefore \dot{x}_1 = \dfrac{-1}{CR} x_1 + \dfrac{1}{C} x_2 \longrightarrow (2)$

or $v_R = v_C \longrightarrow (I_L - I_C)R = v_C$

$\therefore RI_L - RC\dfrac{dv_C}{dt} = v_C$

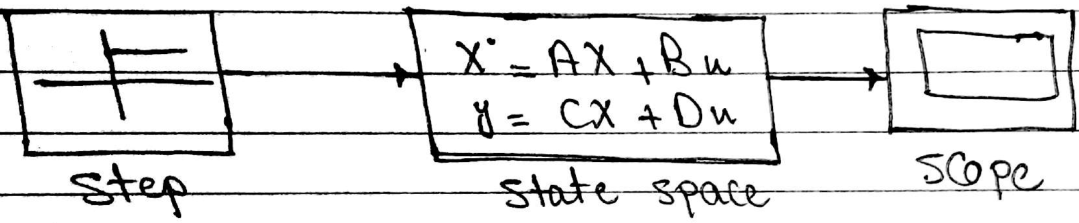
$\therefore \dot{x}_1 = \dfrac{-1}{RC} x_1 + \dfrac{1}{C} x_2 \longrightarrow (2)$

$y = v_R = v_{out} = v_C$

$\therefore y = x_1 \longrightarrow (3)$

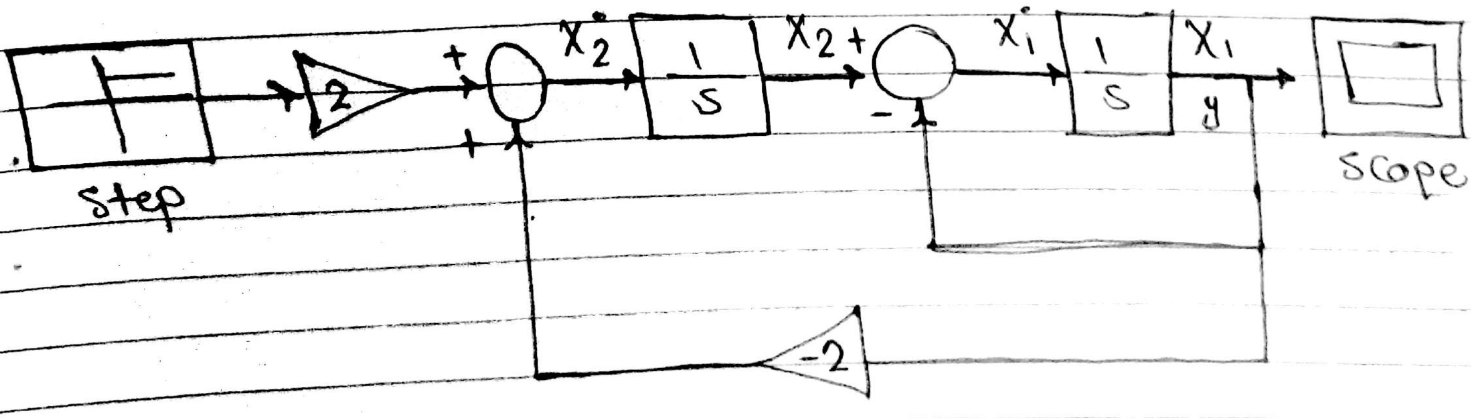
$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -1 & 1 \\ -2 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 2 \end{bmatrix} u(t)$$

$$y = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$



or using integral blocks $(\frac{1}{s})$

or if the question is : using matlab simulink to model the following RLC Circuit using integral blocks.



if the question asked to find Transfer function when using State space approach.

$$T.F. = C\,(SI - A)^{-1}\,B$$

$$SI - A = \begin{bmatrix} s+1 & -1 \\ 2 & s \end{bmatrix}$$

$$(SI - A)^{-1} = \frac{\operatorname{adj}(SI - A)}{|SI - A|} = \frac{1}{s^2 + s + 2}\begin{bmatrix} s & 1 \\ -2 & s+1 \end{bmatrix}$$

$$\therefore T.F. = \begin{bmatrix} 1 & 0 \end{bmatrix}\begin{bmatrix} s & 1 \\ -2 & s+1 \end{bmatrix}\begin{bmatrix} 0 \\ 2 \end{bmatrix}\frac{1}{s^2+s+2}$$

$$\therefore \boxed{T.F. = \frac{2}{s^2+s+2}} \quad \#$$

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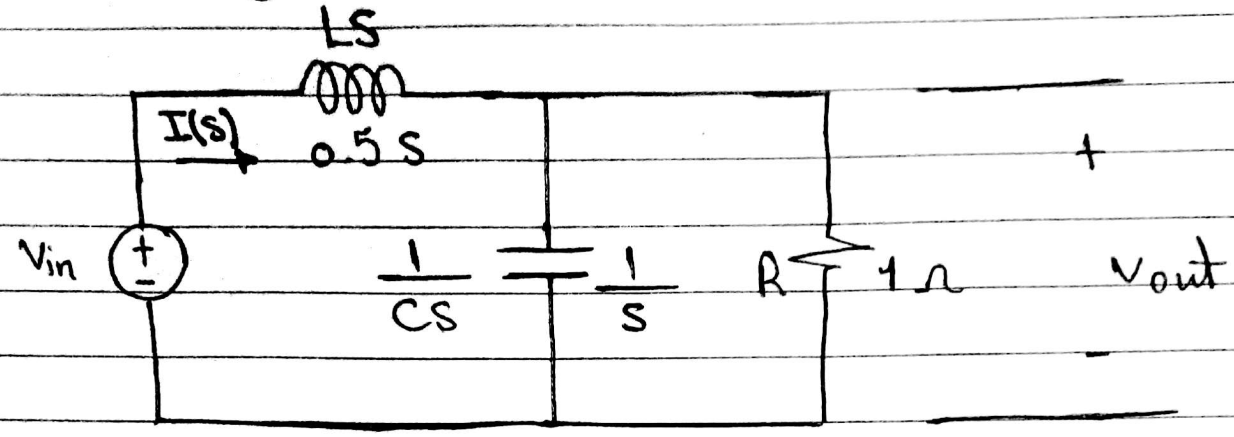
2nd method: using laplace transform



$$T.F = \frac{V_{out}(s)}{V_{in}(s)} = \frac{I(s) * Z_p}{I(s) * Z_t}$$

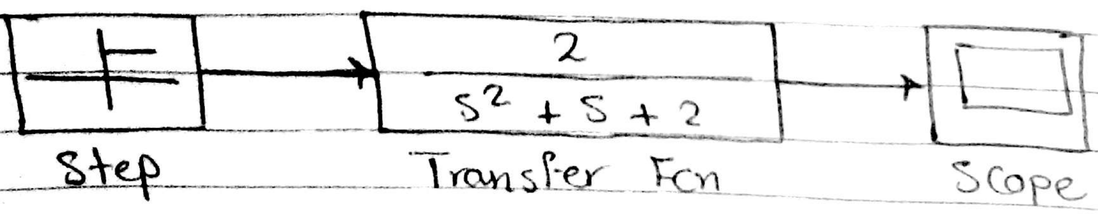
$$Z_p = R \,//\, \frac{1}{CS} = \frac{R * 1/CS}{R + 1/CS} = \frac{1/S}{1 + 1/S}$$

$$\therefore Z_p = \frac{1}{S + 1}$$

$$Z_t = LS + Z_p = 0.5S + \frac{1}{S+1} = \frac{0.5S^2 + 0.5S + 1}{S+1}$$

$$\therefore T.F = \frac{V_{out}(s)}{V_{in}(s)} = \frac{\frac{1}{S+1}}{\frac{0.5S^2+0.5S+1}{S+1}} = \frac{1}{0.5S^2 + 0.5S + 1}$$

$$\therefore T.F = \frac{2}{S^2 + S + 2} \quad \#$$



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No. 4 :-

$$160\,u'(t) + 640\,u(t) = y'''(t) + 18\,y''(t) + 192\,y'(t) + 640\,y(t)$$

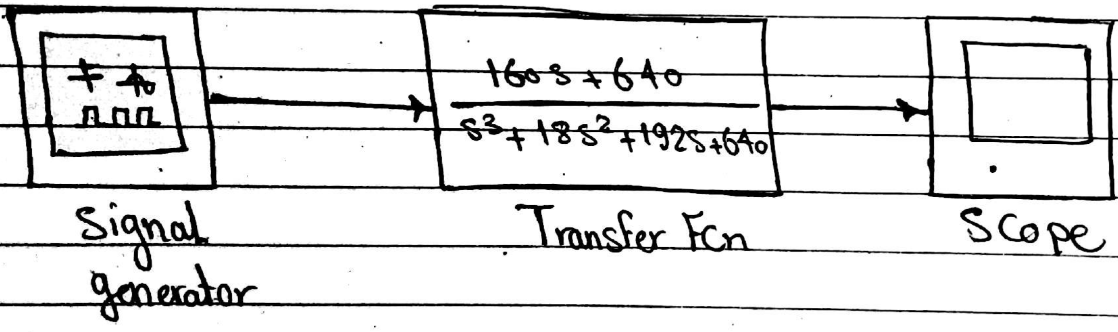
Solution

First method: using Transfer Function.

by laplace transform:

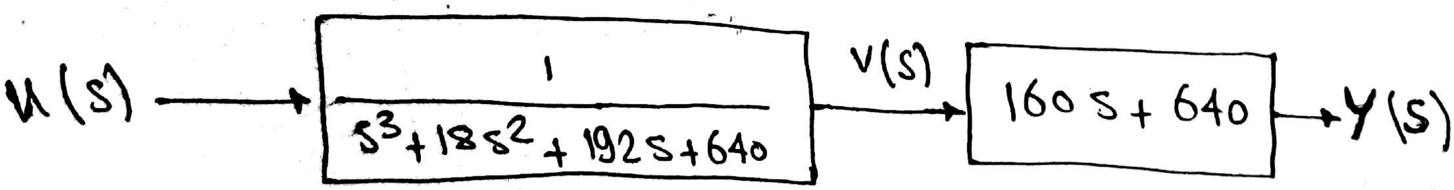
$$\therefore [160\,s + 640]\,u(s) = [s^3 + 18\,s^2 + 192\,s + 640]\,Y(s)$$

$$\therefore T.F. = \frac{Y(s)}{u(s)} = \frac{160\,s + 640}{s^3 + 18\,s^2 + 192\,s + 640}$$



Second Method: using state space.

by dividing the T.F into two blocks



Consider 1st block :-

$$\therefore u(t) = v'''(t) + 18\,v''(t) + 192\,v'(t) + 640\,v(t)$$

let $X_1 = v(t)$ $\xrightarrow{\text{diff.}}$ $\dot{X}_1 = v'(t) = X_2 \longrightarrow (1)$

$X_2 = v'(t)$ $\dot{X}_2 = v''(t) = X_3 \longrightarrow (2)$

$X_3 = v''(t)$ $\dot{X}_3 = v'''(t) = u(t) - 640X_1 - 192X_2 - 18X_3 \longrightarrow (3)$

$$\therefore \begin{bmatrix} \dot{X}_1 \\ \dot{X}_2 \\ \dot{X}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -640 & -192 & -18 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u(t)$$

Consider 2nd block,

$$y(t) = 160\, v'(t) + 640\, v(t) = 640 X_1 + 160 X_2 \longrightarrow (4)$$

$$\therefore y(t) = \begin{bmatrix} 640 & 160 & 0 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix}$$

To get The T.F from state space :-

$$T.F = C\,(SI - A)^{-1} B$$

$$SI - A = \begin{bmatrix} S & -1 & 0 \\ 0 & S & -1 \\ 640 & 192 & S+18 \end{bmatrix}$$

$$(SI - A)^{-1} = \frac{1}{S(S^2 + 18S + 192) + 640} \operatorname{adj}(SI - A)$$

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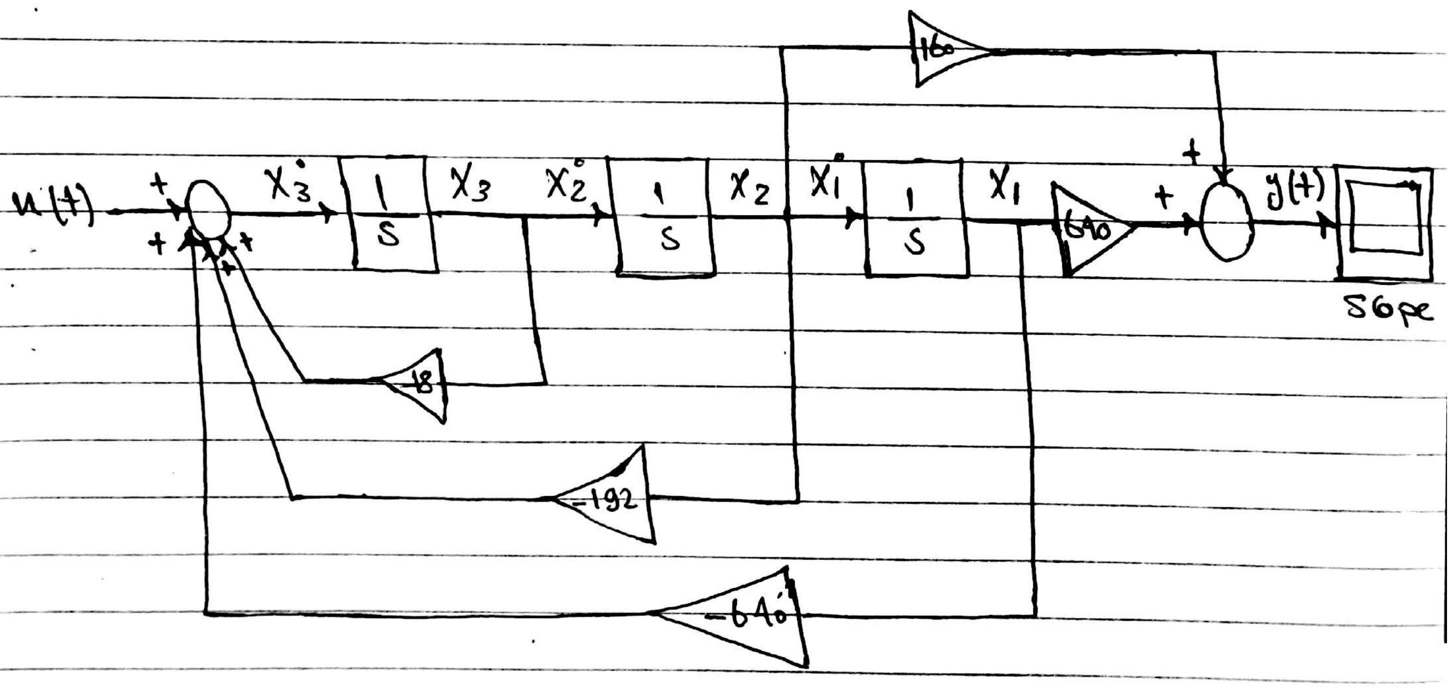
$$\operatorname{adj}(sI-A) = \begin{bmatrix} s^2+18s+192 & -640 & -640s \\ s+18 & s^2+18s & -(192s+640) \\ 1 & s & +s^2 \end{bmatrix}$$

$$\therefore T.F. = C\,(sI-A)^{-1}\,B$$

$$= \begin{bmatrix} 640 & 16 & 0 \end{bmatrix} \frac{1}{s^3+18s^2+192s+640} \left(\operatorname{adj}[sI-A]^{-1}\right)$$

$$\begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} = \frac{1}{s^3+18s^2+192s+640} [$$

$$\therefore T.F. = \frac{160s+640}{s^3+18s^2+192s+640} \quad \#$$



or